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MEMORANDUM

Subject: DOE Comments on 881 Hillside RI/FS

Date: October 17, 1988

This memo presents the DOE comments on the above referenced documents and discusses each individually. The DOE comments are from a memorandum from Mr. Albert E. Whiteman to Mr. Dominick J. Sanchini, dated June 17, 1988.

General Comments (1)

Comment 1.

When considering the alternative of encapsulation, the installation of geomembranes should be considered with long term maintenance in mind. What kind of data is available to show the life of such geomembranes? Although this alternative was not preferred, the consideration of such a membrane does not appear to be a long term solution, being that it may not meet the intent of the proposed EPA groundwater standards.

Response.

The encapsulation alternative includes the use of a geomembrane (called a synthetic membrane in the FS) in the multi-layer cover.

A synthetic membrane was not included in the sidewalls because of the good historical performance of soil-bentonite slurry walls. During the detailed evaluation of the alternative, it became apparent that the terrain is slightly too steep at SWMU 119.1 for construction of slurry walls, and a compacted clayey soil wall in an excavated trench was added to the design where the wall is not perpendicular to the slope.

A synthetic membrane could be incorporated into the design of the compacted soil sidewalls. However, it was felt that the compacted soil sidewall would prove satisfactory in limiting subsurface flow from adjacent areas into the encapsulation system.

The life of synthetic membranes has always been in question. The various manufacturers have conducted tests of inplace membranes and lab tests under high temperatures designed to simulate long times. It is generally accepted that the membranes will provide good service for a period of twenty years (e.g., page 3-11 of EPA, 1985a).

ADMIN RECORD

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A-DU01-000296

The total encapsulation alternative was rejected because it allows the release of volatile organic compounds (VOCs) currently in ground water outside the encapsulation areas.

Comment 2.

The conclusion to eliminate the option of coupling soil flushing with groundwater treatment seems inadequately justified. Although additional soil characterization may be necessary to determine the suitability of the process, the data, as presented in the Feasibility Study, appears to reflect comparable characteristics for a fairly high success in eliminating, if not significantly reducing the VOC's at the 881 Hillside. The additional costs associated with flushing are low, and the need for continuous groundwater treatment may eventually be eliminated. The emphasis here should be for permanent solution to the source problem.

Response.

The FS team was also excited about the potential for application of insitu soil flushing for source cleanup at the 881 Hillside. However, because the technology is unproven and establishing the feasibility of the technology would essentially require a full scale field test, the additional costs were not felt to be justified. In addition, it was decided to include soil flushing as an option in the selected remedial alternative, thereby including the potential benefits in the selected remedial alternative without guaranteeing that Rockwell/DOE would make the technology work.

It is the opinion of the FS team that the selected alternative is a permanent solution to the source problem. Given that separate phase VOCs were not found in the SWMU 119.1 source area, the source of the continued release is concluded to be VOCs adsorbed to soil grains. The adsorbed VOCs will be flushed from the soil by infiltrating precipitation and the release will ultimately cease. As stated above and on page 6-3, active soil flushing will be implemented if natural cleanup does not occur in a reasonable length of time (several years).

Comment 3.

Soil removal or partial soil removal may also prove to be less costly when evaluating long term solutions, in that it will eliminate the problem, and therefore reduce associated costs and time for continuous treatment and monitoring of groundwater.

Response.

Partial removal of contaminated soil is extremely expensive (approximately \$1 million to haul 20 truck loads of soil to a RCRA permitted disposal facility and restore the site). The alternative also involved construction of a french drain with treatment of collected ground water so that the alternative would not allow VOCs currently in the ground water to be released to the environment. Inclusion of the french drain and treatment made the alternative much more expensive than the french drain without soil removal. Therefore, the soil removal alternative was rejected on the basis of cost. If ground water control were not included, the alternative would be rejected on the basis of an unacceptable release to the environment.

The comment correctly identifies that the time required for treatment would be reduced if the source were removed. The cost analyses in the FS assume that treatment and monitoring will continue for thirty years. The FS team was not completely satisfied with this assumption but felt that it was appropriate given the large uncertainties in estimating the time required for cleanup. All of the drain-based alternatives involve some form of source cleanup:

<u>Alternative</u>	<u>Source Cleanup Mechanism</u>
drain alone	flushing by natural infiltration
drain w/ soil flushing	flushing by treated water
drain w/ soil removal	soil removal

Clearly, soil removal will provide the fastest source cleanup, but residual VOC contamination downgradient of the source will be collected in the drain for some time (probably in the range of 3 to 10 years). As can be seen on Table 1, nearly two-thirds of the present worth of treatment plant operation is incurred in the first ten years; therefore, the effects of over-estimating the time required for treatment are strongly muted. It is the opinion of the FS team that the costs of the various alternatives have been reasonable well compared and that estimates prepared in greater detail will yield similar relative results.

Table 1. Present Worth Factors for 10% Discount Rate

<u>Year</u>	<u>Present Worth Factor</u>
0	1.000
1	.909
2	.826
3	.751
4	.683
5	.621
6	.564
7	.513
8	.467
9	.424
10	.386
11	.350
12	.319
13	.290
14	.263
15	.239
16	.218
17	.198
18	.180
19	.164
20	.149
21	.135
22	.123
23	.112
24	.102
25	.092
26	.084
27	.076
28	.069
29	.063
30	.057

Sum of Year 1-30 factors = 9.427
Sum of Year 1-10 factors = 6.145
Sum of Year 11-30 factors = 3.282

Comment 4.

Discussions with Rockwell International indicate that there are datum reflecting the presence of heavy metals. If these measurements are attributable to operations performed at the plant site, it is possible than an ion exchange system may also be required. Additionally, uranium concentrations were encountered, but not further investigated based on statistic probability of contaminant distribution. The sources of these readings are in need of further identification.

Response.

The FS introduces discussions of metal chemistry on page 1-23.

In addition, there are apparently elevated concentrations of uranium, selenium, nickel, strontium and major ions in shallow ground water that may be related to activities at the 881 Hillside SWMUs or to natural geochemical variability. Ground water in the bedrock appears non-impacted...

The conclusions with regard each of the metals were as follows.

1. Uranium -- Uranium concentrations, while elevated with reference concentrations west of the plant, are actually quite low (on average, less than the 40 pCi/l proposed drinking water standard). In addition, the dissolved uranium is probably of natural origin based on isotopic ratios.
2. Selenium -- Selenium concentrations are consistent with concentrations in water well samples from the general Golden area reported in Moran (1976). It is concluded that the source of the selenium is probably the natural soil, although leaching of selenium from the soil may be enhanced at SWMU 119.1.
3. Nickel -- Nickel appears elevated in the vicinity of SWMU 119.1, but the highest concentration is equal to the irrigation standard (there is no drinking water standard).
4. Strontium -- Non-radioactive strontium concentrations are higher in samples from wells on the east side of the plant than in samples from the west side. The FS concludes that the increased strontium concentrations are probably due to natural geochemical processes.

In summary, the FS concludes that although there are four metals that are apparently elevated, none are direct releases from the SWMUs. However, leaching of uranium, selenium and nickel from the soils may be enhanced by materials that have been released from the SWMUs.

Treatment for reduction of metal concentrations is not required. Effluent from the treatment plant will be re-injected into the formation from which the water was originally drawn and the concentrations are below the ground-water protection standards.

Although the source of dissolved uranium in the ground water is not fully understood, it is the conclusion of the FS team that a complete understanding is not required for implementation of an effective remedial action of the real problems at the 881 Hillside. This is based on the following logic.

1. Uranium concentrations are below the proposed drinking water standard.
2. Uranium concentrations, if they result from enhanced leaching by SWMU derived constituents, are expected to decrease over time as the quantity of the leaching agent decreases.

Therefore, remedial action to control uranium is not warranted.

General Comments (2)

Comment 1.

Background soil chemistry must be better defined. Nine upper one foot composite samples are not adequate to define background contaminant applicable to heterogeneous alluvium or bedrock. Without a better (i.e. less conservative) definition of background, detected levels of metals such as mercury, selenium, and strontium should be conservatively interpreted as contamination.

Response.

The original plan for soil characterization assumed that an adequate characterization of background soil chemistry could be obtained from borings immediately up-ground-water-gradient from the SWMUs and from the preponderance of non-impacted

data. This did not turn out to be the case, largely because of widespread bis(2-ethylhexyl)phthalate detections. Therefore, the RI team turned to soil sampling data collected for an entirely different purpose from an area west of the plant. The RI team recognized the limitations of the approach with the following statement.

A one-time sampling of a plot in the west buffer zone is not considered a complete characterization of background alluvial and bedrock materials; however, it serves as a basis for assessing potential contamination (RI, page 4-6).

As noted in the comment, the approach taken results in a very conservative characterization of background and does not really characterize the background chemistry of either colluvial materials mantling Arapahoe bedrock nor the Arapahoe itself. Specifically, it means that mercury and selenium must be nondetectable (less than 0.1 and 3.4 mg/kg, respectively) to be within the background range. Analyses were not performed for strontium in the program used for background characterization, so even a highly conservative background range is not established.

The RI focuses attention on metal concentrations that may be of concern by first listing metal concentrations that are above the upper limit of the range found west of the plant and then by listing those concentrations that are three times the concentrations west of the plant. Three times the upper limit of background was selected as a screening tool because it was felt that natural variations would probably not be larger than this. The three-times-the-upper-limit screening identified five metals that might be elevated: barium, iron, mercury, nickel and zinc. Of these, only mercury was more than ten times the upper limit and it was felt that natural variation might after all account for up to ten times the upper limit west of the plant. Because mercury is not a known waste constituent and was not found in the ground water, it was further concluded that mercury was not of concern.

Strontium were not included in this evaluation because no data were available from sampling west of the plant; however, the detected concentrations were compared to literature values and found to be reasonable.

In conclusion, it is agreed that background soil chemistry has not been well defined by the various programs completed to date. A background characterization program is currently being planned for implementation this fall. However, given that almost every metal concentration is within a factor of

ten of concentrations in the Rocky Flats Alluvium west of the plant (a deposit which should have relatively low metal concentrations because of its coarse grain size) and that metal concentrations in ground water are relatively low, it is reasonable to conclude that the 881 Hillside is not grossly contaminated with metals.

Comment 2.

Volatile organic compound (VOC) soil gas detection is not always supported by borehole sampling and vice versa. Examples are at SWMU 102 where PCE is detected at soil gas point 106 but not in a borehole 25' away and at SWMU 103 where a detected PCE count of over 68,000 is not supported with nearby borehole detection. There are also numerous instances of high soil gas detection surrounded by grid points with zero detection. The data suggest that either the VOC contaminated areas are isolated spills confined in discontinuous high porosity beds or that detection at the level necessary to define low-level plume fringes is not possible (see comments 14 and 15). While the first case is very likely, discussions should be included concerning the radius of influence expected from passive soil gas counters, analysis variability, and counting thresholds (see comment 14) in order to support the quality of the soil gas data and evaluate its future use on-site, particularly in defining plumes on the small scale.

Response.

It is agreed that ion counts obtained in the soil gas survey are not always supported by borehole sampling and vice versa. This is attributable to several different factors, including the following.

1. The determined ion count at every station is presented on the soil gas plates regardless of reliability. The soil gas survey contractor (Petrex) recommended that only values of 1,000 or higher be considered reliable based on the results of QA samples; however, we were instructed by CDH to report every value. QA sampling results are presented in Table 2, on which it can be seen that:
 - a. for locations with detectable ion counts, the count variation averages about 45% of the mean of the two counts, and

Table 2. Soil Gas Sampling QA Results

Location	D u p l i c a t e PCE Counts		Mean	Half Range	Half Range as % of Mean
32	0	0	0	0	0
50	209	965	587	378	64
65	0	0	0	0	0
93	0	0	0	0	0
98	0	0	0	0	0
101	0	0	0	0	0
104	0	0	0	0	0
107	0	0	0	0	0
110	155	455	305	150	49
114	0	0	0	0	0
115	0	1,006	503	503	100
116	968	1,271	1,120	152	14
120	0	0	0	0	0
128	176	306	241	65	27
138	0	0	0	0	0
174	0	0	0	0	0
179	0	0	0	0	0
Average	89	235	162	73	45

- b. counts as high as 1,000 can be coupled with zero counts.

The use of 1,000 ion counts as a reasonable lower threshold of significance is also based on the results of many surveys at other sites and in controlled field tests. Specifically, background levels of volatiles associated with petroleum products varied from a few tens of ion counts per day to two or three hundred in the controlled field test described in Bisque (1984). A conservative background rate of 10 counts per day would result in values of 210 counts in the 881 Hillside survey, which lasted for 21 days.

2. VOCs in soil samples tend to volatilize during sampling, compositing and bottling.
3. VOCs detected in the soil gas survey may emanate from ground water rather than the soil. Concentrations as high as 170 micrograms per liter (ug/l) in ground water would be non-detectable in a saturated solid sample with 30 percent porosity at a detection limit of 25 micrograms per kilogram (ug/kg), because although the water occupies 30% of the sample by volume, it occupies only 14% by weight.
4. VOCs detected in the soil gas may be transported in the gas phase to the point of detection and may not be associated with volatiles in either ground water or soil.

Although there are many reasons for different results between borehole sampling and the soil gas survey (as described above), the two specific examples of differences presented in the comment are well chosen.

PCE was found at 1,541 counts at soil gas point 106 (Figure 1). Given that the range averages about 45% of the value, the true count could be anywhere from about 850 to 2,200, i.e., the true count could be below the reliability limit of 1,000 counts. Borehole BH6-87 was drilled as close as possible to the soil gas point (approximately 25 feet away) to investigate the apparently significant soil gas count. PCE was not detected in the soil. Methylene chloride was found in the samples at relatively low concentrations; the concentrations are so low that there is a reasonable doubt as to the actual presence of the compound in the environment. It is concluded that the soil gas count at point 106 is due to vapor phase transport of volatiles from

some other source (probably uphill) and does not indicate a significant source in the immediate vicinity.

PCE was also detected at a count of over 68,000 (station 88) at SWMU 103 but is not found in the solid samples from BH4-87 or BH63-87 (well 52-87). The volatile results of solid and ground-water samples are as follows.

All detected VOCs in the BH4-87 samples were either also found in the blank (methylene chloride, acetone and 2-butanone) or are believed to be laboratory or field contamination (4-methyl-2-pentanone). Volatiles in the BH4-87 samples are discussed in detail under Specific Comment 3 (page 26 of this memo).

Methylene chloride, acetone and TCE were found in the BH63-87 samples at estimated concentrations below the detection limit, at estimated concentrations and also found in the blank, or at concentrations that only slightly exceed the detection limits. The only potentially significant results are unmodified concentrations that slightly exceed the detection limits for methylene chloride and acetone; however, these are believed to be laboratory contaminants because (1) they are common laboratory contaminants and (2) they are not important contaminants at the 881 Hillside.

VOCs were not found in the water samples from well 52-87.

Thus, it is concluded that PCE is probably present in either the ground water or soils at the location of soil gas point 88 (count is definitely significant), but that significant volatile organic contamination is not present either uphill (BH63-87/well 52-87) or to the south in the utility trench (BH4-87). The RI/FS team was not completely satisfied with the characterization in this area and, as a consequence, recommended a very conservative remedial action (the french drain).

The comment mentions numerous instances of high soil gas detection surrounded by grid points with zero detection. With the exception of the 1,541 counts at point 106, the PCE data do not appear to support this portion of the comment. Based on discussions above, ion counts less than 1,000 are probably not reliable.

The comment goes on to suggest that the VOC detections may represent isolated spills. It is the opinion of the RI team that the isolated detections at point 88 represents a small disposal areas (essentially a spill site).

The comment then poses the question of whether detection is possible at the level necessary to define low-level plume fringes and what radius of influence, analysis variability, and counting thresholds can be expected from passive soil gas counters. The concept in passive soil gas sampling is that the gas in the sampling tube equilibrates with the soil gas. As such the sampler has an infinitesimally small radius of influence. The controlling factor in the size of features than can be identified is the spacing of the sampling points. For example, Bisque (1984) concludes that to insure detection of fresh leak, the grid spacing should be smaller than the depth of the leak. The counting threshold for the Petrex method is one ion over the period of the survey; however, as discussed above, a reliable count is probably on the order of 1,000 counts. Analytical variability (in the laboratory) is probably very small, particularly in comparison with field variability, which has been shown to have a range on the order of $\pm 45\%$ of the value.

Comment 3.

Soil gas detection at the northern perimeter of the 881 Hillside area and soil contamination (primarily bis(2-ethylhexyl)phthalate) at boreholes topographically and hydraulically up-gradient of SWMU 119.1 (boreholes BH9-87, BH15-87, and BH8-87) suggest contamination from source(s) above the hillside and just west of the stock piles. The RI should discuss the source of this possible contamination and consider extending boreholes and/or soil gas samples northward.

Response.

The PCE soil gas counts north of SWMU 119.1 are on the order of 200 to 700 ions collected over a period of 21 days (i.e., 10 to 30 ions per day). These are considered insignificant and unreliable; they would not have been reported without specific direction from CDH. The source of the ions may be gas phase flow from the general plant area toward the south-east (toward Woman Creek and the 881 Hillside) because the prevailing winds create a low pressure trough as they flow off the edge of the Rocky Flats surface.

Frequent detection of bis(2-ethylhexyl)phthalate was also noted by the RI team and was in part ascribed to sample contamination in either the field or laboratory.

Phthalates are components of plasticizers whose presence in a sample or blank can be generally attributed to contact with plastic (page 4-17).

However, the RI also recognized that the detected bis(2-ethylhexyl)phthalate concentrations could result from operations at the plant because the compound is a component of vacuum pump oil and hydraulic oil.

Bis(2-ethylhexyl)phthalate concentrations are definitely elevated up-hill from SWMU 119.1 as compared to samples obtained from within the SWMU area. This is shown in Table 3 and diagrammatically on Figure 2. It is hypothesized that the bis(2-ethylhexyl)phthalate concentrations in excess of about 1,000 ug/kg are significant concentrations and that the lower concentrations (all within the SWMU itself) may be residual levels after extraction by waste solvents. The concentrations uphill probably result from drum storage; the SWMU should probably be extended to include these areas.

It is the opinion of the FS team that additional investigation of uphill areas is not warranted, given the nature of the recommended remedial action. Because the french drain will capture all colluvial ground-water flow, the exact locations of sources is not critical to the performance of the system.

Comment 4.

A primary concern with the work done to date at the 881 Hillside is the degree to which the potential for bedrock contamination, both current and future, has been evaluated. The discussion in Section 5.4.3.1 indicates elevated uranium in the uppermost bedrock aquifer at 59-86BR as well as similar groundwater chemistry and selenium concentration to the overlying alluvial groundwater. Considering the proposal to leave waste in place and treat alluvial groundwater, a subcropping sandstone aquifer in the vicinity of Building 881 has a potential for bedrock contamination during the operational life of the treatment facility. Consideration should be given to placing one or two shallow bedrock aquifer wells down-gradient and slightly east of the three well cluster to indicate if suspected bedrock contamination persists down-gradient and down-dip. Also a concentrated geophysical survey combined with a limited number of boreholes in the area bounded by boreholes 59-86BR, BH63-87, BH53-87 and

Table 3. Bis(2-ethylhexyl)phthalate Profiles at SWMU 119.1

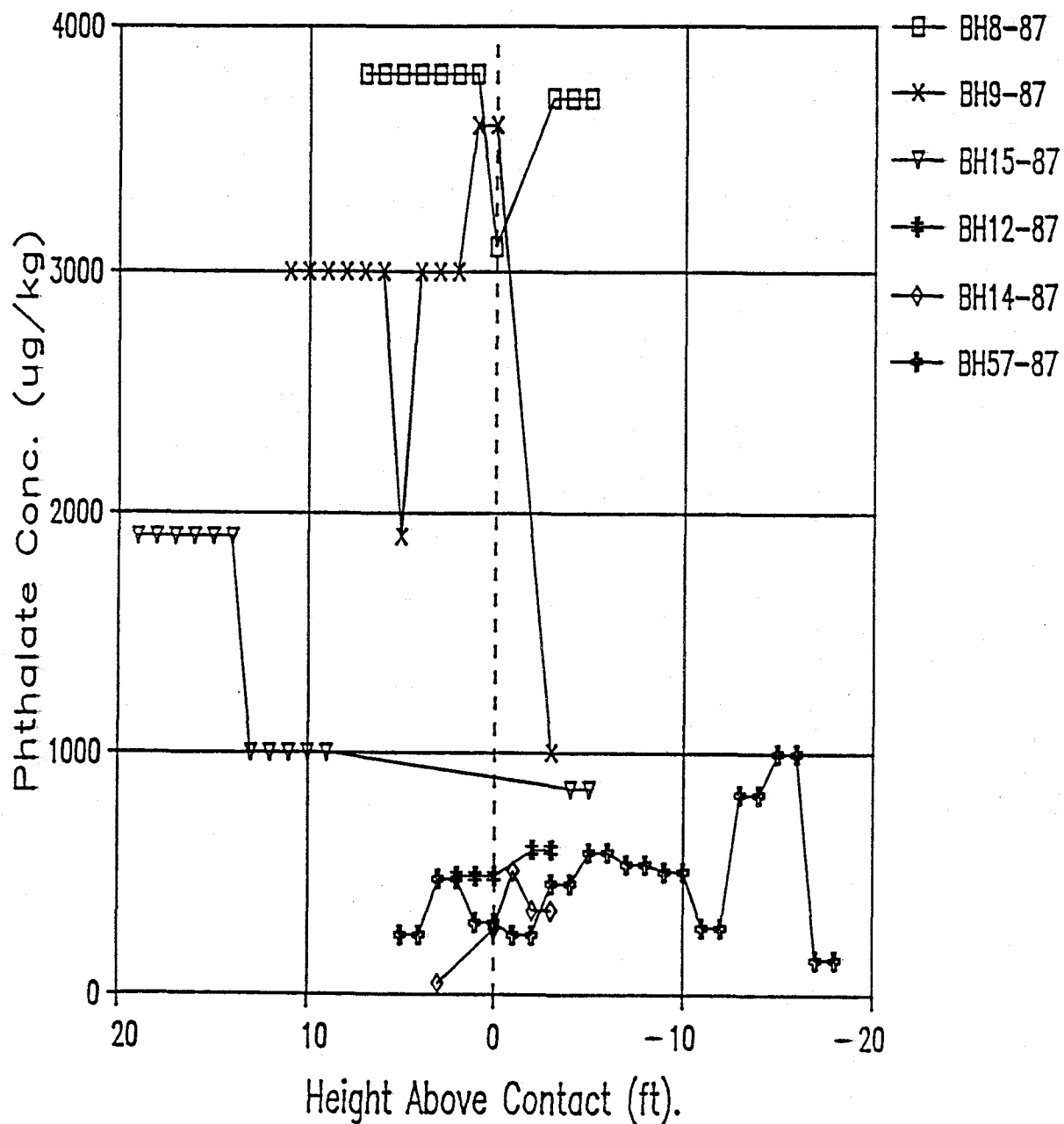
BH8-87		BH9-87		BH15-87	
Depth (feet)	Conc. (ug/kg)	Depth (feet)	Conc. (ug/kg)	Depth (feet)	Conc. (ug/kg)
0		0		0	
6.1	3800	10	3000	5	1900
6.1		6.03		5	
7	3100	6.6	1900	10	1000
--7.2-----		10.08		--19-----	
10.2		11.3	3591	24.1	
12.1	3700	--11.3-----		25.8	850
		14.3			
		14.75	1000		

BH12-87		BH14-87		BH57-87	
Depth (feet)	Conc. (ug/kg)	Depth (feet)	Conc. (ug/kg)	Depth (feet)	Conc. (ug/kg)
0		2		4	
2.25	490	2.9	100U	5.8	250JB
--3.35-----		5.5		8	
5.25		6.5	275	10	480B
6.5	600	--6.5-----		10	
		7.75		12	300JB
		8	514	--12-----	
		6.5		12	
		9	350	14	250JB
				14	
				16	460B
				16	
				18	590B
				18	
				20	540B
				20	
				22	510B
				22	
				24	280JB
				24	
				26	830B
				26	
				28	1000B
				28	
				30	150JB

Notes:

- indicates bedrock contact.
- concentrations are for samples from lesser depth to depth with value shown.
- J indicates value estimated below detection limit.
- B indicates compound detected in blank.

Figure 2. Bis(2-ethylhexyl)phthalate Profiles at SWMU 119.1



BH3-87 could be implemented to specify the suspected area of bedrock/alluvium communication.

Response.

Two seemingly superficial, yet quite significant points should be made with regard this comment.

First, the only bedrock sandstone units that even begin to behave like aquifers beneath the Rocky Flats Plant have been found near the 903 Pad. Otherwise, bedrock consists of low permeability claystone and relatively low permeability sandstone. It does neither Rockwell nor DOE any good to call the sandstone unit at the 881 Hillside an aquifer. Note that the sandstone in 59-86BR has a saturated thickness of 3.5 feet or less and a hydraulic conductivity of 3×10^{-4} cm/s. These data imply that the maximum sustainable pumping rate from a well completed at this location is less than 0.1 gpm; clearly this unit should not be called an aquifer.

Second, the recommended remedial alternative does not involve leaving significant amounts of waste in-place; the wastes were removed from SWMU 119.1 (the important site on the 881 Hillside) in 1972. Instead, the remedial alternative deals with residual contamination after removal of the wastes.

Nonetheless, the RI team shares the concern expressed by the reviewer with regard the evaluation of bedrock contamination. Detailed discussions together with supporting data are presented in the RI dealing with the evaluation of chemical conditions in the bedrock. The essence of the discussions is presented in Table 4 and can be summarized as follows.

1. At SWMU 119.1, bedrock ground water is distinctly different from colluvial ground water (based on major ion, uranium and organic differences); therefore, colluvial ground water is in poor connection with bedrock ground water and there is little potential for impact to the bedrock ground water.
2. At SWMUs 103, 106 and 107 (south of Building 881), deeper bedrock ground water is distinctly different from colluvial and shallowest bedrock ground water (based primarily on uranium differences); however, shallowest bedrock ground water cannot be differentiated from colluvial ground water and the two systems appear to be well connected based on chemical similarities. The effects of lithologic variation

Table 4. Summary of Bedrock Ground-Water Quality Discussions

SWMU 119.1

	Colluvial	Bedrock 5-87BR
Major Ions	DIFFERENT	
Strontium	Similar	
Selenium	Similar	
Uranium	DIFFERENT	
Organics	PRESENT	ABSENT

SWMUs 103, 106 and 107

	End of Skimming Pond		3-Well Cluster		
	Colluvial 2-87	Deep Bedrock 3-87BR	Colluvial 69-86	Shallow Bedrock 59-86BR	Deep Bedrock 8-87BR
Major Ions	Similar		Similar		DIFFERENT
Strontium	Similar		Similar		
Selenium	Absent		Similar		ABSENT
Uranium	DIFFERENT		Similar		DIFFERENT
Organics	Absent		Absent		

are discussed under Specific Comment 6 in this document (pages 29-30).

3. Although the colluvial and shallowest bedrock ground waters appear connected at the three well cluster, neither of these waters is contaminated. Uranium is the only constituent that could be considered a contaminant, and it is not considered to be a problem because the concentrations are low (less than even the proposed drinking water standard) and because it appears to be natural uranium rather than either enriched or depleted uranium.

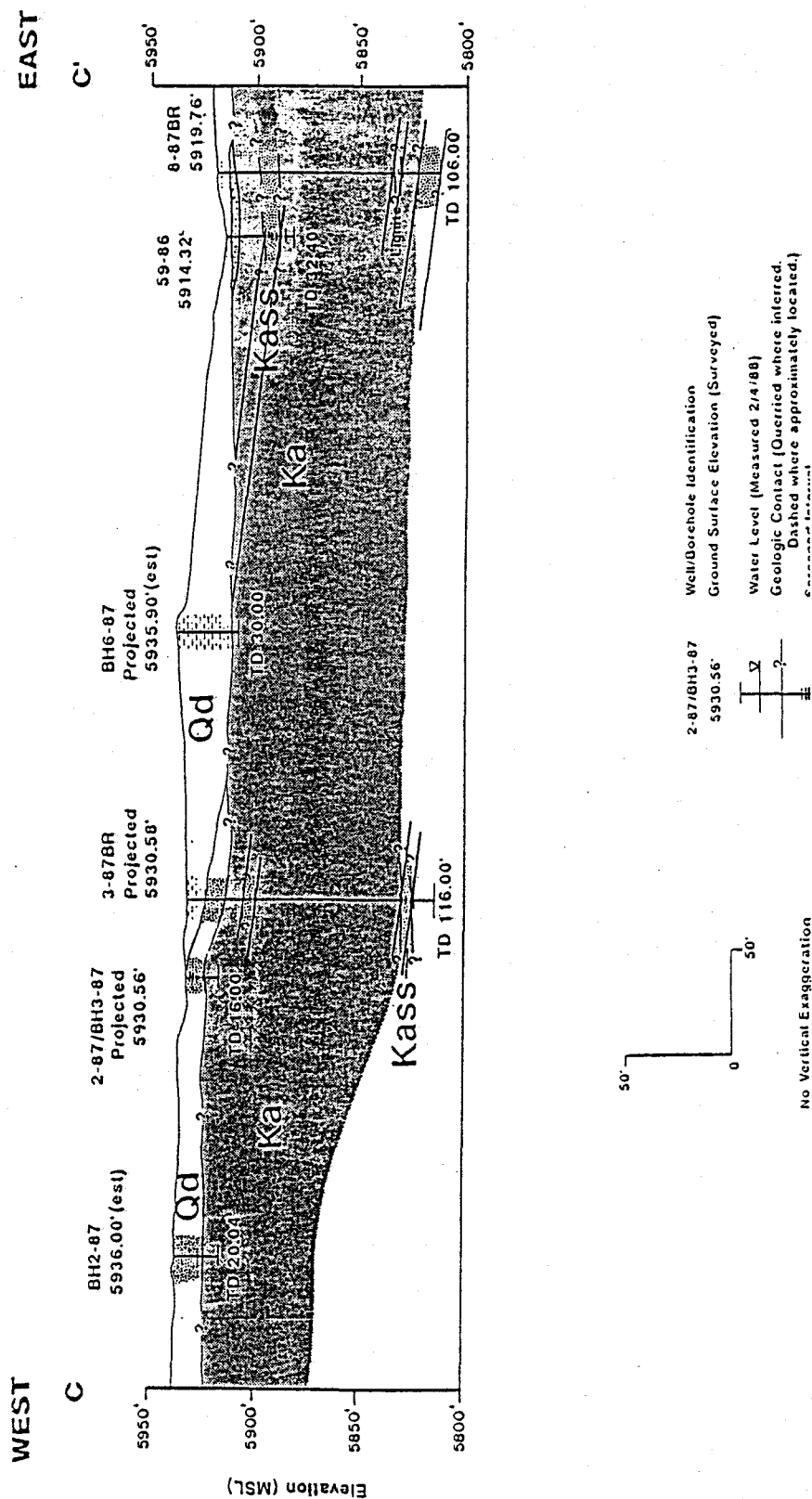
Based on these observations, the RI team concluded that there is currently no bedrock ground-water contamination.

The potential for future degradation of water quality in the shallow sandstone at the three well cluster is considered minimal because of the location of the french drain. The connection between the shallowest bedrock ground water and the colluvial ground water is presumed to be at the subcrop of the sandstone. Based on a seven degree dip to the east, the sandstone subcrops slightly east of BH6-86 (Figure 3). Figure 4 shows the presumed location of the subcrop in plan view, together with the location of the french drain. If the sandstone were continuous, there is potential for future impact to the bedrock system. However, the drain alignment has been drilled since preparation of the RI (Figure 5 shows boring locations as presented in Aguirre, 1988), and all of the borings found claystone bedrock. Therefore, it is concluded that the sandstone is not sufficiently extensive to present a potential conduit for flow of contaminated water from areas upgradient of the french drain into the bedrock system.

Comment 5.

The farthest wells down-gradient of SWMUs 102, 106, and 107 (3-87BR, 69-86, 59-86BR, 8-87BR, and 2-87) all show semi-volatile and volatile organic contamination and therefore do not bound the contaminant plumes from the area south of Building 881. Although downgradient alluvial wells 68-86 and 53-87 are not contaminated, there is a significant gap (about 1500') between them. Considering the heterogenous composition of the alluvium, an alluvial well between 68-86 and 53-87 would confirm that no further southeasterly contamination has occurred and the plume is contained north of Woman Creek. The same comment applies to the gap between wells 64-86 and 65-86 downgradient of SWMU 119.1.

Figure 3. 59-86BR SANDSTONE IN CROSS SECTION



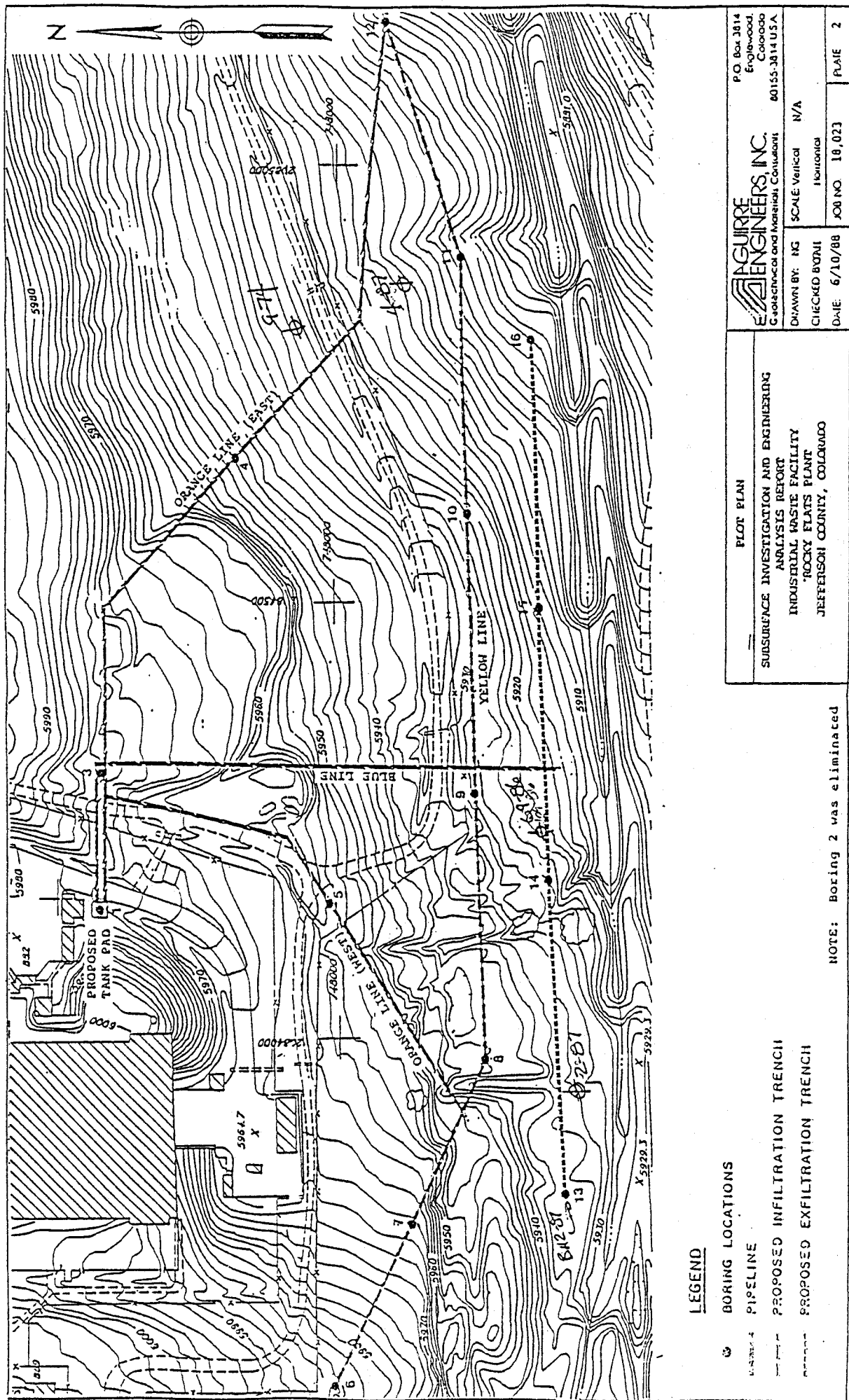


Figure 5. AGUIRRE (1988) DRILLING LOCATIONS

Response.

Ground-water samples from the above-mentioned wells downgradient of Building 881 do not exhibit either volatile or semi-volatile contamination. Volatile organic data from the RI are presented in Appendix A. The data for each of the wells are as follows.

Well 2-87 - The first of the two analyses presented in the RI reports 6 micrograms per liter (ug/l) 1,1-dichloroethene. The second analysis did not detect this compound at 5 ug/l. It is the opinion of the RI team that repeated analyses will continue to find non-detectable organics.

Well 3-87BR - There are five analyses of samples from 3-87BR presented in the RI. Two of these were for all of the Hazardous Substances List (HSL) volatiles and one of these found methylene chloride and toluene at estimated concentrations of 2 ug/l. These were not confirmed in the second analysis.

Both analyses found acetone at 33 ug/l and at an estimated 3 ug/l; however, acetone was also found in the blanks for both samples. Although the RI does not present blank analyses, the estimated 3 ug/l is clearly an interference from lab contamination because the detection in the blank must have been at least equal to the detection limit (5 ug/l). The 33 ug/l is also probably the result of laboratory contamination and, under strict contract laboratory protocol, should have been reported as not detected. According to EPA (1985b), this is the correct procedure if the common laboratory contaminants (methylene chloride, acetone and toluene) are detected in the sample at a concentration of less than ten (10) times the concentration in the blank sample. Again, the results of the blank analysis are not reported in the RI but acetone must have been on the order of 5 ug/l; hence, any detections of less than about 50 ug/l should have been reported as not detected.

Based on this information, it is the opinion of the RI team that there are not volatile organics in the ground water in the vicinity of 3-87BR.

Well 8-87BR - The single sample from 8-87BR that was analyzed for all of the HSL volatiles contained methylene chloride at an estimated concentration of 2 ug/l, toluene at an estimated concentration of 1 ug/l and acetone at 11

ug/l (acetone was also found in the blank). These are the common laboratory contaminants and the detection of the first two in the sample at such low concentrations does not mean that they are present in the ground water. Acetone should probably have been reported as not detected according to contract laboratory protocol (EPA, 1985b).

Based on this information, it is concluded that there are not volatile organics in the ground water in the vicinity of 8-87BR.

Well 59-86 - The single sample analyzed from 59-86 for all of the HSL volatiles contained acetone at an estimated concentration of 2 ug/l and acetone was also detected in the blank. Acetone should have been reported as not detected; it clearly is not present in the sample.

Well 69-86 - Detectable volatiles have never been reported for any of the samples analyzed from 69-86.

Ground-water samples from these wells have generally not been analyzed for semi-volatile organic compounds. Analyses were performed for semi-volatiles in 1986 and data should be available for well 69-86 (59-86BR was not completed until the 1987 drilling program). The original Part B (Rockwell International, 1986b) does not contain the results for 69-86; however, based on the data available at the time, it was concluded that semi-volatiles were not a problem in the ground water.

Solid samples collected from boreholes in the 1986 and 1987 drilling programs were analyzed for both volatile and semi-volatile compounds. Of the wells mentioned in the comment, only 2-87 was drilled as a borehole (BH3-87) with consequent solids chemical analyses. Results are presented in the RI that indicate the following.

Volatiles were found in all four of the samples; however, the detected compounds are common laboratory contaminants and were either at estimated concentrations or were also found in the blank. The only exception to this is the detection of 60 ug/l 2-butanone in the bedrock sample. It seems unreasonable that 2-butanone would be in the bedrock immediately beneath the colluvium and not in the colluvium through which transport to the bedrock must have occurred. Although 2-butanone was not found in the blank for this analysis, it has been found in other blanks (e.g., the blank for some of the samples from this hole) and it is concluded that the 2-butanone is laboratory contamination.

If the preceding conclusion is accepted, there are no volatiles in the solid samples from BH3-87.

The only semi-volatile detected was bis(2-ethylhexyl) phthalate at concentrations ranging from 660 to 940 ug/kg in all four samples. However, bis(2-ethylhexyl) phthalate was also found in the blank at an unknown level. According to EPA (1985b), phthalate esters are also common contaminants and sample concentrations should be reported as not detected if they are less than ten (10) times the concentration found in the blank. Assuming that the detection limit in the blank was 150 ug/kg (the only not detected value presented in the RI is for sample BH148703W1), then any values less than 1500 should not be reported if bis(2-ethylhexyl) phthalate was also found in the blank. Based on these considerations, it is concluded that semi-volatile compounds are not present in the solid samples from BH3-87.

Based on all of the above, it is the opinion of the RI team that the organic problem behind Building 881 has been bounded by the existing wells.

Specific Comments

Comment 1 (Page 4-8 and Appendix D).

The field screening procedure discussed in Appendix D, Pages D-10 to D-16 is based on field detection of organics and radionuclides. Given differential retardation of metals versus VOCs, this section should discuss the potential for field screening to miss HSL metals that may persist below the surface composite sample.

Response.

The reviewer is correct in identifying that the field screening technique focuses on organic contamination. The RI team thought this an appropriate approach because most of the wastes were organic-bearing and because water quality analyses from the 1986 field program did not indicate metal contamination. The results of the 1987 water quality sampling program support the conclusion that metals are not a problem at the 881 Hillside.

Comment 2 (Page 4-15, 1st paragraph, 3rd sentence).

Table 4-6 indicates two samples near the 903 pad are elevated in plutonium above background: BH168702CT and BH17870005, not one as discussed.

Response.

It is agreed that the text accompanying Table 4-6 is not clear. It was intended to point out that only one result was clearly elevated above background (0.91 ± 0.38 pCi/g). The other value (0.38 ± 0.14) is neither clearly within the background range (0.1 ± 0.2) nor clearly outside.

Comment 3 (Page 4-21, last paragraph, last sentence).

The log of borehole BH4-87 shows the base of a presumably porous sand and gravel at a depth of 15 ft. With this information, the "isolated occurrence" of 4-methyl-2-pentanone is potentially significant as it indicates possible contamination of relatively porous colluvium. This sentence should be rewritten indicating why little significance is placed on this sample.

Response.

Sample BH048715CT was collected from a depth of 15.3 to 15.7 feet in BH4-87. The sampled material was sand and gravel that was continuous from the surface to 15.7 feet, where claystone bedrock was encountered. Based on more detailed evaluation of utility alignments behind the building, it is likely that the hole was drilled through backfill around a buried water line.

On reviewing the data, the statements in the text seem appropriate, although the dismissal of 4-methyl-2-pentanone may appear somewhat flippant. The data are as follows.

Methylene Chloride was detected in all four of the samples at estimated concentrations and it was also found in the blank. Methylene chloride is probably a laboratory contaminant.

Acetone was found in all of the samples at concentrations ranging from 200 to 650 ug/kg but was also found in the blank. Assuming that the detection limit for acetone is 50 ug/kg and that the detection in the blank (value unknown) is equal to the detection limit, all values of 500 ug/kg or less should have been reported as not detected according to EPA (1985b). Acetone would only have to be 65 ug/kg in the

blank for all of the reported values to be questionable. Based on these considerations, it is concluded that the reported acetone results are probably laboratory contamination.

2-Butanone was also found in all of the samples and in the blank. Values range from 110 to 150 ug/kg. 2-butanone is not one of the common laboratory contaminants; therefore, EPA (1985b) specifies reporting not detected if the sample is less than five (5) times the blank value instead of ten (10) times as for the common contaminants. Assuming that the value in the blank was equal to the detection limit of 25 ug/kg, all but one of the sample results should have been reported as not detected. The blank concentration would only have to be 30 ug/kg for all of the values to be reported as not detected. Therefore, it is concluded that 2-butanone is probably a laboratory contaminant.

4-Methyl-2-pentanone is the only other volatile compound detected in the samples from BH4-87 and it was found in only one of the four samples at 68 ug/kg (detection limit of 50 ug/kg). This is the only detection of the compound in any solid sample. Because the compound is not found anywhere else at the Hillside, it is concluded that the result is questionable and does not have environmental significance; it may be due to contamination in the field or laboratory.

Comment 4 (Page 4-27, last sentence in Section 4.5).

Volatile organics (2-butanone) are detected 3 ft into bedrock at well BH3-87 at a concentration of 60 ug/kg.

Response.

As discussed earlier, it seems unreasonable that 2-butanone would be in the bedrock immediately beneath the colluvium at a concentration of 60 ug/l and not be present in the colluvium through which transport to the bedrock must have occurred. Although 2-butanone was not found in the blank for this analysis, it has been found in other blanks (e.g., the blank for two of the four samples from this hole) and it is concluded that the 2-butanone is laboratory contamination. Please find additional discussion of 2-butanone in response to Comment 7 (page 33 of this memo).

Comment 5 (Page 5-26, 1st paragraph).

The statement that a conservative solute would require 80 years to travel to the site boundary is potentially misleading since it does not recognize that much of the solute in the Woman Creek Valley fill will be discharged to Woman Creek thereby leaving the plant boundary well before 80 yrs. This sentence should indicate that this is a conservative estimate for groundwater transport only.

Response.

The statement on page 5-26 is as follows.

Assuming that ground water flows at this velocity for about half the year, a molecule of a conservative solute would travel the 10,000 feet to the property boundary in about 80 years.

It seems fairly clear that ground-water transport is being discussed. It was intended that the reader take some comfort in the fact that the ground-water pathway does not rapidly deliver contaminants to the property boundary (please note that there are no contaminants in the valley fill alluvium to be delivered).

However, the reviewer is correct in recognizing the close connection between the surface and ground-water systems. Flow in the valley fill alluvium is controlled by recharge events; when actually being recharged (and for a relatively short time thereafter), the alluvium is continuously saturated from the headwaters of the creek to the property boundary. The alluvium may become fully saturated and discharge to the surface system along some reaches (especially downstream), or, if the recharge event is of short duration, the surface system may only flow into the alluvium and never receive recharge from the alluvium. In any event, the system then drains toward the property boundary when not being recharged; some reaches finally become unsaturated, either due to downstream drainage or evapotranspirative loss.

This hydraulic system has little potential to transport the contaminants of concern from the 881 Hillside to the property boundary. This is based on the following scenario.

1. The contaminants of concern are volatile organics and it is assumed that they will ultimately be delivered to the valley fill alluvium if nothing is done to control their movement.

2. The volatiles will arrive as ground-water flow because the colluvium does not respond quickly to precipitation events (high permeability zones are encased in low permeability clayey soils).
3. The volatiles will be present as a plume in an isolated pod of saturation in the valley fill alluvium when the recharge event occurs.
4. The recharge event will saturate the alluvium and cause some of the volatile bearing ground water to enter the surface water system.
 - a. The volatiles in the surface water will volatilize because of the turbulence of the flood flow or because the equilibrium partial pressure of the compound cannot be achieved in the open air.
 - b. The volatiles in the ground water will be strongly diluted by the recharge from the surface water (minimum dilution factor of two); they will move downstream as subsurface flow under the topographic gradient (alluvium is full to the ground surface).
5. Downstream movement of the volatiles remaining in the ground-water system will cease when the hydraulic connection between separate saturated pool is broken by discharge to evapotranspiration which Hurr (1976) estimates to be approximately 0.25 cubic feet per second (about 32 inches per year).
6. Some of the volatiles will be removed from the water as volatilization occurs from the stagnant pool of saturation, but there may also be a net concentration increase because of evaporative concentration.
7. Movement will begin again from step 4 when another recharge event occurs.

It is the opinion of the RI team that an excursion of volatile organics from the 881 Hillside through the Woman Creek Valley Fill Alluvium is not an imminent danger and may never happen. Further, discussions are considered appropriate that downplay the importance of the pathway.

Comment 6 (Page 5-52, 2nd paragraph).

The borehole logs in Appendix A-3 show that well 8-87BR is screened completely through 3 ft of lignite. The ionic

constituents of this well are compared to 59-87BR that is completed in an upper sandstone. This paragraph should indicate the differences in lithology and point out why a shift to a sodium-sulfate groundwater can be attributed only to groundwater communication and not a change in bedrock constituents.

Response.

It is agreed that the lithologic differences should have been mentioned here.

The point of the discussion with regard the chemistry of the samples from the uppermost bedrock (sandstone) and the deeper bedrock (lignite) was to evaluate whether the chemical conditions shed any light on the degree of interconnection of ground water in the uppermost and deeper bedrock. Although the lithologic differences probably play an important role in controlling the chemistry of the pore water, it still seems likely that large quantities of uppermost bedrock ground water are not being delivered to the deeper bedrock. This is based on the concept that if large quantities of shallow water were being flushed through the deeper bedrock, the reaction sites in the deeper bedrock solids would equilibrate with the water and the water in the deeper bedrock would be similar to water in the uppermost bedrock.

Comment 7 (Pg 5-62, summary discussion (5) & last paragraph).

While it is probably true that discontinuous gravel lenses contain organic contamination in the horizontal plane near the surface and close to the soil gas detectors, borehole samples indicate vertical contaminant traces well into the claystone bedrock. BH57-87 shows the most prominent bedrock contamination with traces of butanon, TCA, TCE, and TCA detected to a depth of 25 ft, 13 ft into bedrock. Methylene chloride and acetone were detected at significant concentrations 4 ft into claystone bedrock at BH14-87 and butanon was detected 3 ft into bedrock at BH9-87. The summary discussion should recognize this and indicate that, although bedrock aquifer contamination has not been detected, there is a potential for significant vertical dispersion of these organic constituents and hence contamination of the upper bedrock aquifer.

Response.

The comment is correct in noting that eleven volatile compounds were detected in the solid samples from BH57-87 and

that some of the detections were relatively deep into the bedrock; however, most of the reported values were modified with Js or Bs (all detected compounds and reported concentrations are presented on Table 5). Of course, Js indicate that the analyst recognized the compound but the concentration was less than the contract laboratory program required detection limit (and usually lower than the end-point of the equipment calibration); Bs indicate that the compound was found in the laboratory blank associated with the sample.

The following five detected compounds are considered to be environmentally insignificant.

Bromomethane was found in only one of the twelve samples from BH57-87 and it was at an estimated concentration of 6 ug/kg (about one-tenth the detection limit). Because the detection of bromomethane is at such a low level and the compound was not found stratigraphically higher, it is concluded that the bromomethane detection is questionable and that it may result from contamination by laboratory or field procedures.

Methylene chloride was found in all but one of the samples; however, seven of the results should have been reported as not detected following EPA (1985b) procedures because methylene chloride was also found in the blank. The remaining four results were at estimated concentrations below the detection limit. Because methylene chloride is not a common contaminant at SWMU 119.1 and because the detected concentrations are so low (estimated at below the detection limit), it is concluded that the presence of methylene chloride in the environment is questionable. The estimated detections are likely the result of contamination in the laboratory.

Acetone was found in every sample but was also found in all the blanks. Assuming acetone was found at the detection limit of 50 ug/kg in the blanks, all of the results should have been reported as not detected, following EPA (1985b). It is concluded that acetone is not present in the samples.

1,1-Dichloroethene was found in one of the twelve samples at an estimated concentration of 8 ug/kg. Clearly, 1,1-dichloroethene is not an important soil contaminant.

Table 5. Volatile Organic Compounds found in Solid Samples from BH57-87

Sample No.	Depth (ft)	BMA	MCl	Ace	1,1-DCE	1,2-DCA	2-But	TCA	TCE	2-TCA	PCE	Tol
BH578704DH	4.0-5.8	50U	10J	79B	25U	25U	50U	47	8J	25U	52	25U
BH578708DH	8.0-10.0	50U	16J	110B	25U	25U	50U	16J	33	25U	96	25U
BH578710UC	10.0-12.0	50U	10J	85B	8J	25U	50U	25U	81	6J	67	6J
Weathered Claystone @ 12.0 feet												
BH578712CT	12.0-14.0	50U	20J	100B	25U	10J	50U	110	150	27	62	25
BH578714BR	14.0-16.0	50U	21JB	260B	25U	5J	100	28	7J	8J	25U	25U
BH578716DH	16.0-18.0	50U	36B	200B	25U	25U	46J	10J	10J	25U	25U	25U
BH578718DH	18.0-20.0	50U	25JB	220B	25U	25U	50U	110	7J	25U	25U	25U
BH578720DH	20.0-22.0	6J	25JB	210B	25U	25U	62	25U	8J	25U	25U	25U
BH578722DH	22.0-24.0	50U	26B	110B	25U	25U	50U	13J	21J	25U	5J	25U
BH578724DH	24.0-26.0	50U	6JB	53B	25U	25U	50U	25U	25U	25U	25U	25U
BH578726DH	26.0-28.0	50U	6JB	65B	25U	25U	50U	11J	25U	25U	25U	25U
BH578728DH	28.0-30.0	50U	25U	38JB	25U	25U	50U	25U	25U	25U	25U	25U

Notes:

All units are ug/kg.
BMA = Bromomethane.
MCl = Methylene chloride.
Ace = Acetone.
1,1-DCE = 1,1-Dichloroethene.
1,2-DCA = 1,2-Dichloroethane.
2-But = 2-Butanone.
TCA = 1,1,1-Trichloroethane.
TCE = Trichloroethene
2-TCA = 1,1,2-Trichloroethane.
PCE = Tetrachloroethene.
Tol = Toluene.

1,2-Dichloroethane was found at estimated concentrations in two samples. Again, it is concluded that the compound is not an important soil contaminant.

With the exception of 1,1-dichloroethene and 1,2-dichloroethane, these compounds are rarely detected in the ground-water samples from wells 43-87 (built in BH 57-87) and 9-74.

Table 6 shows the volatile results if the above compounds are removed from consideration and only the un-modified values reported for the other compounds. It seems fairly obvious that there has been some penetration of volatile compounds into the bedrock; however, these data do not indicate "significant vertical dispersion". In fact, significant concentrations of most of the compounds were only found in the top two feet of the bedrock. In addition, most of these compounds (TCA, TCE, 1,1,2-TCA and PCE) are the real organic contaminants in the ground-water samples from wells 43-87 and 9-74.

Two compounds were found deeper in the bedrock. 2-butanone (methyl ethyl ketone) and 1,1,1-trichloroethane (TCA) were found to depths of 22 and 20 feet below ground (10 and 8 feet into bedrock). The 2-butanone results are rather unusual because (1) the compound is not detected in the soils (as opposed to bedrock) and (2) the compound is not detected in the ground water. If all of the compound found in the bedrock were present as dissolved 2-butanone in the pore water and the saturated porosity were 30 percent by volume, the water would have a 2-butanone concentration of about 700 ug/l in order to produce a solid concentration of 100 ug/kg. This should be easily detectable in the ground water, but it is not. 2-butanone is relatively soluble in water (about 23% by weight) and is less dense than water with a specific gravity of about 0.8 (Sax and Lewis, 1987); thus it is unlikely that 2-butanone is in the bedrock as a separate phase sinking liquid. Therefore, the environmental significance of the 2-butanone detections are questionable. TCA is probably present in the soils as it is a major organic constituent in the ground water.

There is one other factor involved at the location of wells 9-74 and 43-87 (BH57-87) that may influence the results. The two wells are extremely close together (approximately four or five feet apart). Well 43-87 was constructed to replace 9-74 because neither the geologic log nor completion details were available for 9-74. Well 9-74 has a total depth of approximately 19 feet below ground which is very close to the

Table 6. Significant Volatile Organics in Solid
Samples from BH57-87

<u>Sample No.</u>	<u>Depth (ft)</u>	<u>2-But</u>	<u>TCA</u>	<u>TCE</u>	<u>2-TCA</u>	<u>PCE</u>	<u>Tol</u>
BH578704DH	4.0-5.8	-	47	-	-	52	-
BH578708DH	8.0-10.0	-	-	33	-	96	-
BH578710UC	10.0-12.0	-	-	81	-	67	-

Weathered Claystone @ 12.0 feet

BH578712CT	12.0-14.0	-	110	150	27	62	25
BH578714BR	14.0-16.0	100	28	-	-	-	-
BH578716DH	16.0-18.0	-	-	-	-	-	-
BH578718DH	18.0-20.0	-	110	-	-	-	-
BH578720DH	20.0-22.0	62	-	-	-	-	-
BH578722DH	22.0-24.0	-	-	-	-	-	-
BH578724DH	24.0-26.0	-	-	-	-	-	-
BH578726DH	26.0-28.0	-	-	-	-	-	-
BH578728DH	28.0-30.0	-	-	-	-	-	-

Notes:

All units are ug/kg.

- indicates analysis was run but result rejected (see text).

2-But = 2-Butanone.

TCA = 1,1,1-Trichloroethane.

TCE = Trichloroethene

2-TCA = 1,1,2-Trichloroethane.

PCE = Tetrachloroethene.

Tol = Toluene.

depth of penetration of 2-butanone and TCA. Therefore, because

1. most organic compounds are found in the soil and the first two feet of bedrock,
2. the deepest penetrating compound (2-butanone) is not an important organic constituent in the ground water and may actually be an artifact of laboratory or field procedures,
3. borehole BH57-87 is so close to well 9-74 that colluvial ground water in 9-74 may be the source of organics in bedrock below a depth of about two feet (Well 9-74 penetrates into bedrock a depth equivalent to the deepest penetration of TCA),

it is concluded that volatile organics have penetrated approximately two feet into bedrock. This is consistent with the three and four foot penetrations at other borings mentioned in the comment.

Comment 8 (Pages 6-25 - 6-28, Section 6.3).

This section should discuss the methods used to collect and analyze sediment. Are these composite samples or surface grab samples? Was the entire sample analyzed or only the clay fraction? Further reference to any techniques cannot be found in this section.

Response.

It was intended that the opening sentence of Section 6.3 serve as a reference to the 1986 Part B, in which methods are described.

Sediment samples were collected during the 1986 Phase 2 initial site characterization from creeks and ditches that traverse the Rocky Flats Plant.

It is agreed that the methods are poorly referenced.

Sampling methods are presented in Section 3.1 (Sediment Sampling) of Appendix E-4 (Description of Field Activities) to Rockwell International (1986b). Analytical methods are presented in Section 4.0 (Laboratory Analysis Plan) of Rockwell International (1986a).

Comment 9 (Page 9-1, 2nd paragraph).

Section 5.4.2.1 discusses elevated uranium concentrations in the uppermost bedrock aquifer at well 59-86BR. This information is omitted in the statement that "uranium contamination appears confined to the alluvial groundwater and possibly surface water." This sentence should be rewritten to indicate possible uranium infiltration to the bedrock aquifer.

Response.

The summary in Section 9.0 should mention the elevated uranium in the very shallow sandstone intercepted by well 59-86BR.

Comment 10 (Appendix A, Section 3.1.2.4, last sentence).

It is indicated here that soil gas samples were to be taken at increased density to establish plumes detected during initial screening, presumably using the passive gas detectors. Why wasn't this done to enhance borehole placement? There are a number of alluvial boreholes that were placed near points of soil gas detection that showed no VOC contamination. A more detailed soil gas survey using a active sampler might have better targeted the center of contamination, particularly for isolated "hot spots" detected near the Building 881 footing drain.

Response.

The soil gas survey is described in Appendix C of the RI, as follows.

The RI work plan called for real time measurement of soil gas. Real time measurements are extracted by inserting a hollow conduit into the soil to a given depth and evacuating a predesignated volume of gas...a sample is extracted and analyzed... The disadvantages are the added equipment and cost required...and a reduction in the mobility of the sampling vehicle. Another disadvantage is that real time methods increase the lower detection limit. For these reasons it was decided to use Petrex's time integrated method.

... Time integration also alleviates any variations in the contaminant concentrations due to transient situations... In addition, all equipment required to perform the sampling can be carried into the target area by two individuals. This reduces traffic in areas where heavy traffic might

cause re-suspension of soil possibly contaminated with radioactive contaminants...

... The RI Work Plan grid spacing for the soil gas stations (90 foot centers) was determined to be inconsistent with Petrex's recommended alignment. Therefore, samplers were placed every 120 feet along a grid line using sixty-foot offsets for each successive grid line. This offset grid was designed so that adjacent grid lines are sampled at non-aligned stations, thus interrupting the orthoganol pattern of a uniform grid.

A further disadvantage of passive surveys that was not mentioned is that infilling with more closely spaced samplers is not possible because all data must be collected over the same time interval.

Comment 11 (Page B-8, Section 3.3).

Given the VOC contamination detected at BH9-87 and BH15-87 as well as the potential contamination at the 903 Pad, the location of the background VES point (VES-1 is between the 903 Pad and the contaminated boreholes) was probably not a good one.

Response.

The application of vertical electrical soundings at various locations on the 881 Hillside was intended to provide stratigraphic information rather than detect contaminants. The location of VES-1 was chosen as a background stratigraphic location, i.e., outside of known SWMUs. The subsequent detection of VOCs in this vicinity should have no impact on the validity of the stratigraphic model of the location.

Comment 12 (Page B-19, Section 5.1).

There are additional EM-31 anomalies that are not listed or discussed in this section. Areas of elevated conductivity exist at N-34900, E-21580 and N-35080, E-21820 corresponding to contamination at SWMU 119.1. There is also a significant EM-34 vertical dipole anomaly (N-35120, E-20980) under the southeast corner of Building 881. Due to the deeper resolution of the vertical dipole, this anomaly is probably not influenced by the fill material composing the slope on the southeast corner of the building. Also anomalies cannot be located at N-35120, E-21280 (EM-34 vertical) and N-34940, E-21280 (EM-34 horizontal). The likely locations are probably N-34940, E-21280 and N-34820, E-21100, respectively.

Response.

The apparent anomalies not discussed in the text were eliminated due to the presence of cultural interferences at these locations (e.g., fences and powerlines). The area near the southeast corner of Building 881 was heavily influenced by large metallic objects and the fence which surrounds the area.

The difficulty in locating the anomalies listed on page B-19 results from the inadvertant transposition of the EM-34 Vertical and EM-34 Horizontal labels in the list. Those locations identified as horizontal anomalies are actually vertical anomalies and vice versa.

Comment 13 (Page B-20, Section 5, 1st paragraph).

The anomaly near grid point N-35120, E-21280 cannot be found on any of the EM-31 or EM-34 maps. This grid coordinate is actually in SWMU 130 not across SWMU 106, as discussed.

Response.

The references to locations N-34120, E-21280 and N-34760, E-20740 on page B-20 are reversed. The anomaly near SWMU 107 is located at N-34760, E-20740. The low conductivity area associated with fire debris is located at N-35120, E-21280.

Comment 14 (Page C-5, Table C-1).

Thirteen of the duplicate soil gas samples have zero VOC detection in at least one of the paired filaments. Of these, three zero detections are paired with significant VOC detection (352, 408, and 1,006 counts). Considering detections as low as 107 counts are reported on the maps as significant, the quality of the analysis is in question if nearly 25% of the zero detection filaments are in areas of detectable soil gas concentrations. The variability of the lab analysis and the detection limits should be discussed as they may help explain the sporadic nature of the field samples.

Response.

The reviewer has correctly identified the key to both this comment and interpretation of the soil gas data, i.e., what level of detection is meaningful. As discussed earlier, the determined ion count at every station is presented on the soil gas plates. The soil gas survey contractor (Petrex) recommended that only values of 1,000 or higher be considered reliable; however, we were instructed by CDH to report every value.

The use of 1,000 ion counts as a reasonable lower threshold of significance appears reasonable based on the results of QA samples (Table 2), on which it can be seen that:

1. for locations with detectable ion counts, the count variation averages about 45% of the mean of the two counts, and
2. counts as high as 1,000 can be coupled with zero counts.

In addition, background levels of volatiles associated with petroleum products varied from a few tens of ion counts per day to two or three hundred in a controlled field test described in Bisque (1984). A conservative background rate of 10 counts per day would result in values of 210 counts in the 881 Hillside survey, which lasted for 21 days.

The counting threshold for the Petrex method is one ion over the period of the survey; however, as discussed above, a significant count is probably on the order of 1,000 counts. Analytical variability (in the laboratory) is probably very small, particularly in comparison with field variability, which has been shown to have a range on the order of 45% of the value.

Comment 15 (Appendix C-2).

The soil gas procedures do not address the manner by which excavated soil for sampling tube placement is put back in place and compacted. It would seem that variability in the soil gas counts could be introduced by arbitrary differences in backfill permeability controlling gaseous flux to the sampling tube.

Response.

The procedures should have discussed how excavated soil is placed into the tube excavation after placement of the tube. In general, soils from the excavation are placed above the tube and lightly compacted by hand pressure or foot pressure.

The goal in the survey is to have the gases at equilibrium in the soil in the immediate vicinity of the sampler and inside the sampler. Because most soils are geologically young and relatively loose, it is assumed that the soils being surveyed are also in this state, and no special care is taken to compact the soils placed on top of the sampler.

One of the good features of the Petrex method is that if all samplers are treated identically, most biases apply equally to all samples.

Comment 16 (Appendix F).

What is NR? Not Required? Please indicate as a footnote.

Response.

Good comment. NR means Not Requested.

Comment 17 (Appendix E-3, packer test data for well 4-87).

The depth to water column does not correspond to the drawdown information and exceeds the depth of the casing at 19.7 ft.

Response.

The depth to water column was in error but was not used in the analyses. Table 7 presents the correct depths to water.

Comment 18 (App E-3, bail-down/recovery test, well 8-87BR).

All of the depth to water values after t_0 are below the bottom of the casing at 89.34.

Response.

The total casing depth below ground is 89.34 feet. The total casing depth below top of casing is 91.34 feet. The well was drawn down in 4 minutes by bailing to 91.30 feet below top of casing.

Table 7. 4-87 Pumping Test Data

4-87 P-Test
06/02/87

Time (min)	Recovery Time (min)	Depth to Water (feet)	Draw- down (feet)
0		8.59	.00
1.5		11.55	2.96
2		11.85	3.26
2.5		12.05	3.46
3		12.34	3.75
10		12.44	3.84
10.5		12.59	4.00
11		12.68	4.08
11.5		12.72	4.13
12		12.77	4.18
12.5		12.82	4.23
13		12.83	4.24
13.5		12.86	4.27
14		12.89	4.29
15		12.82	4.23
16		12.76	4.17
20	3	11.79	3.20
22	5	10.33	1.74
22.5	5.5	10.03	1.44
23	6	9.71	1.11
23.5	6.5	9.53	.94
24	7	9.48	.89
24.5	7.5	9.44	.84
25	8	9.42	.82
25.5	8.5	9.38	.78
26	9	9.29	.70
27	10	9.31	.72
28	11	9.29	.70
29	12	9.28	.69
30	13	9.26	.67
31	14	9.24	.65
32	15	9.22	.63
33	16	9.22	.63
35	18	9.18	.58
37	20	9.17	.57
39	22	9.10	.51
44	27	8.99	.40
49	32	9.00	.41

Table 7. 4-87 Pumping Test Data (continued)

Time (min)	Recovery Time (min)	Depth to Water (feet)	Draw- down (feet)
55	38	8.96	.36
60	43	8.93	.33
65	48	8.84	.25
70	53	8.88	.28
71	54	8.86	.27
76	59	8.78	.19
82	65	8.80	.21

Comment 19 (Appendix E-3).

Data for hydraulic conductivity (slug) tests conducted at wells 2-87, 3-87BR, 4-87, 5-87BR, and 8-87BR are presented without analysis. A worksheet supporting the hydraulic conductivity calculations should be included that shows all well specific information and empirical coefficients. Assuming the method of Bouwer and Rice (1976) was used, this data should include the values of L , r_w , r_c , D , and the C , A , and B coefficients. Verification calculations using the method of Bouwer and Rice were conducted on the drawdown information provided and were generally within half an order of magnitude of the values given in Table 5-2. Documentation of the parameters discussed above as well as modifications that might have been applied to the method would better support verification.

Response.

The RI team agrees with the reviewer that documentation of analytical methods is needed.

The five wells mentioned in the comment were tested by the three different methods shown in Table 8. Two of the five wells were tested twice by different methods with excellent agreement between the results. The reviewer notes that when he applied Bouwer and Rice (1976) to the data, he produced results within half an order of magnitude of those reported in Table 8.

Table 8. Hydraulic Conductivity Test Methods and Results

<u>Well</u>	<u>Test Method</u>	<u>Result (cm/s)</u>	<u>Comments</u>
2-87	Pumping Slug	4x10 ⁻⁵ 3x10 ⁻⁵	Q=0.074 gpm Data not in E-3
3-87BR	Bail-Down/Recovery	3x10 ⁻⁶	Remove 11 liters in 21 minutes
4-87	Pumping	5x10 ⁻⁴	Q=?
5-87BR	Slug Bail-Down/Recovery	7x10 ⁻⁵ 7x10 ⁻⁵	Remove 8.3 liters in 10 minutes
8-87BR	Bail-Down/Recovery	3x10 ⁻⁶	Remove 2.1 liters in 4 minutes

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October 17, 1988
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Appendix A
VOLATILE ORGANIC DATA
SELECTED WELLS

Well 2-87 2-87
 Date 07/08/87 10/07/87
 Sample ID 2-87-07-08-87 2-87-10-07-87
 Batch No. 0387-881-025 0687-881-013
 Comment

Chloromethane		
Bromomethane		
Vinyl Chloride		
Chloroethane		
Methylene Chloride		
Acetone		
Carbon Disulfide		
1,1-Dichloroethene	6	5U
1,1-Dichloroethane		
Trans-1,2-Dichloroethene	4U	5U
Chloroform	4U	5U
1,2-Dichloroethane	4U	5U
2-Butanone		
1,1,1-Trichloroethane	4U	5U
Carbon Tetrachloride	4U	5U
Vinyl Acetate		
Bromodichloromethane		
1,2-Dichloropropane		
Trans-1,3-Dichloropropene	4U	5U
Trichloroethene		
Dibromochloromethane		
1,1,2-Trichloroethane	4U	5U
Benzene		
cis-1,3-Dichloropropene		
2-Chloroethylvinylether		
Bromoform		
4-Methyl-2-pentanone		
2-Hexanone		
Tetrachloroethene	4U	5U
1,1,2,2-Tetrachloroethane		
Toluene		
Chlorobenzene		
Ethylbenzene		
Styrene		
Total Xylenes		

Notes: Blank means not analyzed. U means analyzed but not detected at level given. J means present at a level below the detection limit. B means present in the laboratory blank for the batch. Units are micrograms per liter (ug/l).

Well	3-87	3-87	3-87	3-87	3-87	3-87
Date	06/16/87	06/16/87	07/08/87	10/05/87	10/05/87	10/05/87
Sample ID	3-87-06-16-87	GW0387	3-87-07-08-87	3-87-10-05-87	3-87	3-87
Batch No.	0587-881-005	8706-042-0100	0387-881-026	0687-881-011	8710-017-0030	Split
Comment		Split				
Chloromethane		10U			10U	
Bromomethane		10U			10U	
Vinyl Chloride		10U			10U	
Chloroethane		10U			10U	
Methylene Chloride		2J			5U	
Acetone		33B			3JB	
Carbon Disulfide		5U			5U	
1,1-Dichloroethene	4U	5U	4U	5U	5U	
1,1-Dichloroethane		5U			5U	
Trans-1,2-Dichloroethene	4U	5U	4U	5U	5U	
Chloroform	4U	5U	4U	5U	5U	
1,2-Dichloroethane	4U	5U	4U	5U	5U	
2-Butanone		10U			10U	
1,1,1-Trichloroethane	4U	5U	4U	5U	5U	
Carbon Tetrachloride	4U	5U	4U	5U	5U	
Vinyl Acetate		10U			10U	
Bromodichloromethane		5U			5U	
1,2-Dichloropropane		5U			5U	
Trans-1,3-Dichloropropene		5U			5U	
Trichloroethene	4U	5U	4U	5U	5U	
Dibromochloromethane		5U			5U	
1,1,2-Trichloroethane	4U	5U	4U	5U	5U	
Benzene		5U			5U	
cis-1,3-Dichloropropene		5U			5U	
2-Chloroethylvinylether		10U			10U	
Bromoform		5U			5U	
4-Methyl-2-pentanone		10U			10U	
2-Hexanone		10U			10U	
Tetrachloroethene	4U	5U	4U	5U	5U	
1,1,2,2-Tetrachloroethane		5U			5U	
Toluene		5U			5U	
Chlorobenzene		2J			5U	
Ethylbenzene		5U			5U	
Styrene		5U			5U	
Total Xylenes		5U			5U	

Notes: Blank means not analyzed. U means analyzed but not detected at level given. J means present at a level below the detection limit. B means present in the laboratory blank for the batch. Units are micrograms per liter (ug/l).

Well	8-87	8-87	8-87
Date	06/15/87	06/15/87	07/08/87
Sample ID	8-87-06-15-87	GW0887	8-87-07-08-87
Batch No.	0587-881-004	8706-042-0090	0387-881-028
Comment		Split	0687-881-012

Chloromethane		10U		
Bromomethane		10U		
Vinyl Chloride		10U		
Chloroethane		10U		
Methylene Chloride		2J		
Acetone		11B		
Carbon Disulfide		5U		
1,1-Dichloroethene	4U	2J	4U	5U
1,1-Dichloroethane		5U		
Trans-1,2-Dichloroethene	4U	5U	4U	5U
Chloroform	4U	5U	4U	5U
1,2-Dichloroethane	4U	5U	4U	5U
2-Butanone		10U		
1,1,1-Trichloroethane	4U	5U	4U	5U
Carbon Tetrachloride	4U	5U	4U	5U
Vinyl Acetate		10U		
Bromodichloromethane		5U		
1,2-Dichloropropane		5U		
Trans-1,3-Dichloropropene		5U		
Trichloroethene	4U	5U	4U	5U
Dibromochloromethane		5U		
1,1,2-Trichloroethane	4U	5U	4U	5U
Benzene		5U		
cis-1,3-Dichloropropene		5U		
2-Chloroethylvinylether		10U		
Bromoform		5U		
4-Methyl-2-pentanone		10U		
2-Hexanone		10U		
Tetrachloroethene	4U	5U	4U	5U
1,1,2,2-Tetrachloroethane		5U		
Toluene		5U		
Chlorobenzene		1J		
Ethylbenzene		5U		
Styrene		5U		
Total Xylenes		5U		

Notes: Blank means not analyzed. U means analyzed but not detected at level given. J means present at a level below the detection limit. B means present in the laboratory blank for the batch. Units are micrograms per liter (ug/l).

Well	59-86	59-86	59-86	59-86	59-86
Date	10/08/86	04/09/87	04/30/87	07/06/87	10/07/87
Sample ID	G598610860	59-86-04-09-87	59-86-04-30-87	59-86-07-06-87	59-86-10-07-87
Batch No.	8610-028-0210	0187-881-043	0187-881-067	0387-881-024	0487-881-011
Comment					
Chloromethane	10U				
Bromomethane	10U				
Vinyl Chloride	10U				
Chloroethane	10U				
Methylene Chloride	5U				
Acetone	2BJ				
Carbon Disulfide	5U				
1,1-Dichloroethene	5U				
1,1-Dichloroethane	5U				
Trans-1,2-Dichloroethene	5U				
Chloroform	5U				
1,2-Dichloroethane	5U				
2-Butanone	10U				
1,1,1-Trichloroethane	5U				
Carbon Tetrachloride	5U				
Vinyl Acetate	10U				
Bromodichloromethane	5U				
1,2-Dichloropropane	5U				
Trans-1,3-Dichloropropene	5U				
Trichloroethene	5U				
Dibromochloromethane	5U				
1,1,2-Trichloroethane	5U				
Benzene	5U				
cis-1,3-Dichloropropene	5U				
2-Chloroethylvinylether	10U				
Bromoform	5U				
4-Methyl-2-pentanone	10U				
2-Hexanone	10U				
Tetrachloroethene	5U				
1,1,2,2-Tetrachloroethane	5U				
Toluene	5U				
Chlorobenzene	5U				
Ethylbenzene	5U				
Styrene	5U				
Total Xylenes	5U				

Notes: Blank means not analyzed. U means analyzed but not detected at level given. J means present at a level below the detection limit. B means present in the laboratory blank for the batch. Units are micrograms per liter (ug/l).

Well	69-86	69-86	69-86
Date	04/29/87	07/06/87	10/07/87
Sample ID	69-86-04-29-87	69-86-07-06-87	69-86-10-07-87
Batch No.	0187-881-064	0387-881-023	0487-881-012
Comment			

Chloromethane			
Bromomethane			
Vinyl Chloride			
Chloroethane			
Methylene Chloride			
Acetone			
Carbon Disulfide			
1,1-Dichloroethene	4U	4U	5U
1,1-Dichloroethane			
Trans-1,2-Dichloroethene	4U	4U	5U
Chloroform	4U	4U	5U
1,2-Dichloroethane	4U	4U	5U
2-Butanone			
1,1,1-Trichloroethane	4U	4U	5U
Carbon Tetrachloride	4U	4U	5U
Vinyl Acetate			
Bromodichloromethane			
1,2-Dichloropropane			
Trans-1,3-Dichloropropene			
Trichloroethene	4U	4U	5U
Dibromochloromethane			
1,1,2-Trichloroethane	4U	4U	5U
Benzene			
cis-1,3-Dichloropropene			
2-Chloroethylvinylether			
Bromoform			
4-Methyl-2-pentanone			
2-Hexanone			
Tetrachloroethene	4U	4U	5U
1,1,2,2-Tetrachloroethane			
Toluene			
Chlorobenzene			
Ethylbenzene			
Styrene			
Total Xylenes			

Notes: Blank means not analyzed. U means analyzed but not detected at level given. J means present at a level below the detection limit. B means present in the laboratory blank for the batch. Units are micrograms per liter (ug/l).

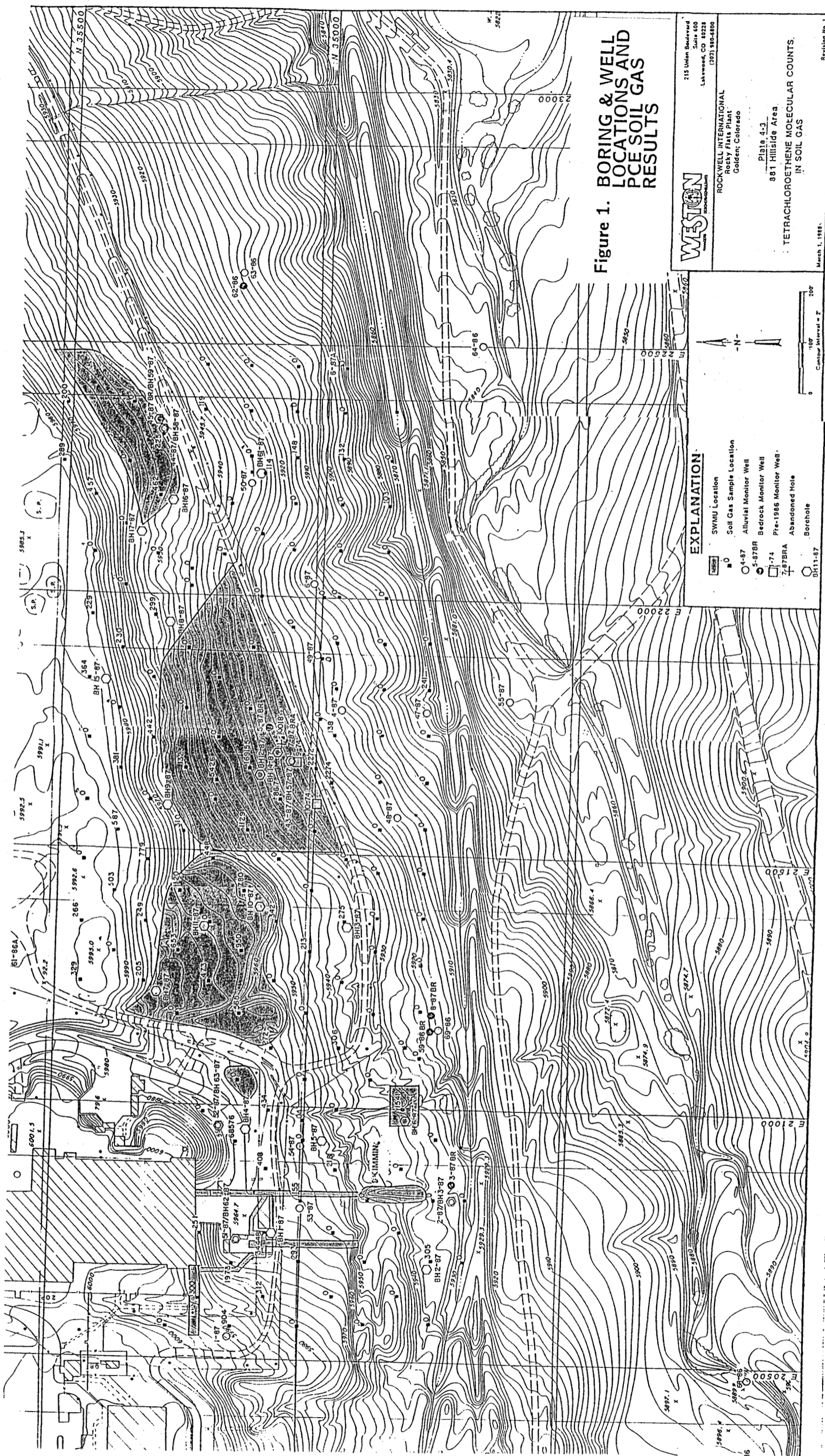




Figure 4. 59-86BR SANDSTONE IN PLAN



215 Union Boulevard
Suite 600
Lakewood, CO 80228
(303) 910-4100

ROCKWELL INTERNATIONAL
Rocky Flats Plant
Golden, Colorado

Plate 4-3
881 Hillside Area

TETRACHLOROETHENE MOLECULAR COUNTS
IN SOIL GAS

March 1, 1988

Revision No. 1

EXPLANATION

- SWAU Location
- Soil Gas Sample Location
- 4-87 Alluvial Monitor Well
- 5-87BR Bedrock Monitor Well
- 7-87BRA Pie-1986 Monitor Well
- Abandoned Hole
- Borehole

Contour Interval = 2'